MRI of Overuse Injury in the Elite Athlete

William B. Morrison, M.D.
Associate Professor of Radiology
Thomas Jefferson University Hospital
Philadelphia, PA USA

William.Morrison@Jefferson.edu

ATHLETES: OVERUSE INJURIES VERY COMMON

- Muscle
- Joints
- Tendon
- Ligament
- Bone

How is this Relevant to My Practice?

- High performance athletes get similar injuries as 'regular' people… but:
  - More of them, & at a younger age
  - More commonly imaged
  - Secondary gain involved
- All the cases here are high performance athletes – but most injuries are conventional
- Exceptions
  - Some weird sport-specific patterns of stress and other injuries
  - Acute injuries as opposed to overuse

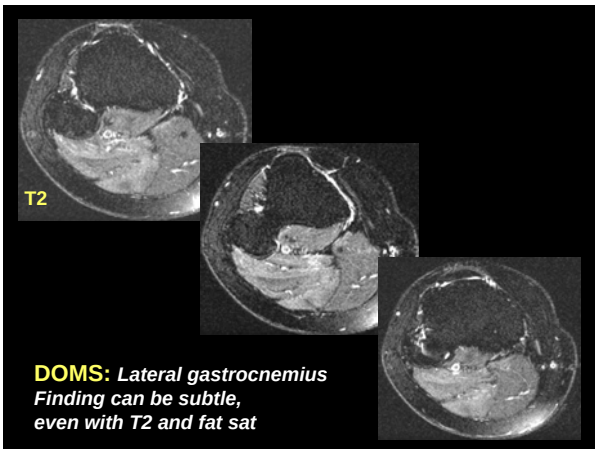
MUSCLE / SOFT TISSUE INJURY

Muscle Injury

- Overuse
  - DOMS
- Acute injury
  - Tendon
  - Myotendinous junction
  - Muscle belly

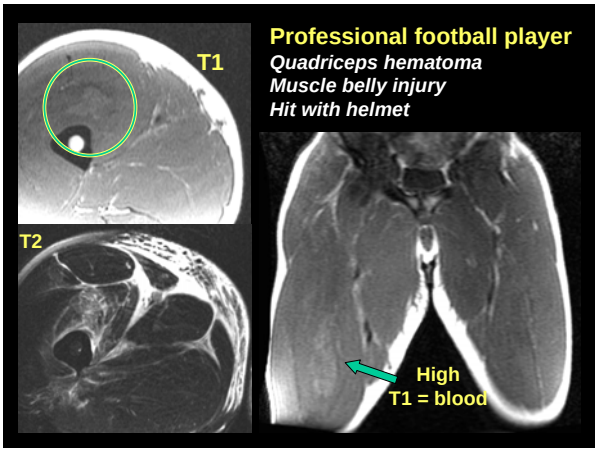
Delayed Onset Muscle Soreness (DOMS)

- All athletes are susceptible if they change training regimen
- Athletes tend to work out intensely – leads to muscle injury
- Rarely imaged ("no pain no gain")
  - Weightlifting / aerobic exercise
  - 24hr later – soreness
  - Can be severe, even look like a tear



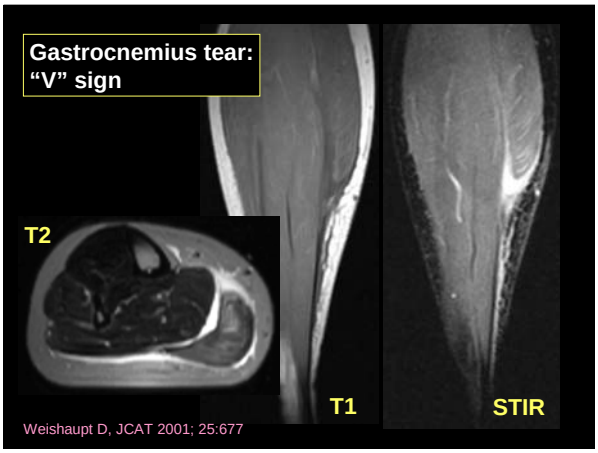
Acute Muscle Injury

- Direct → muscle belly, esp quadriceps
  - esp rugby, football
- Indirect → myotendinous junction
  - eccentric contraction
  - sudden acceleration / deceleration



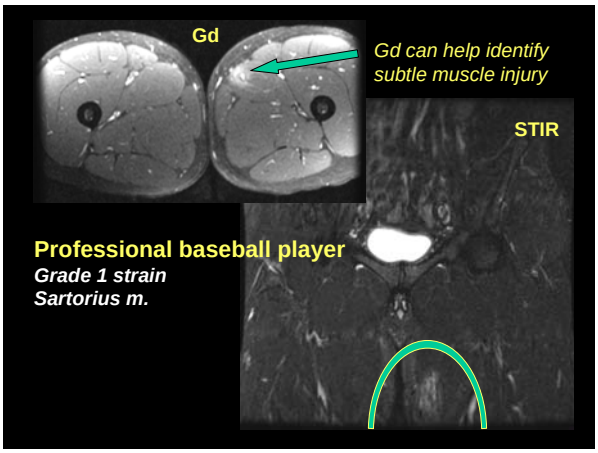
Acute Injury – Myotendinous Unit

- Myotendinous Junction
  - 'weak link' of normal myotendinous complex
  - Common place for injury
  - Most common mechanism: eccentric contraction (muscle lengthens and contracts at the same time)



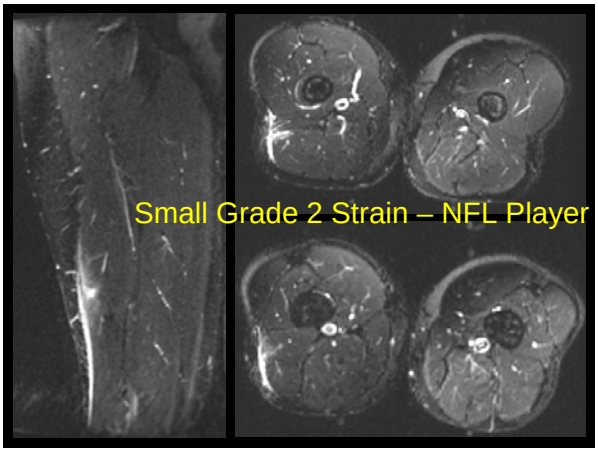
Grade 1 Muscle Strain

- Ill-defined edema



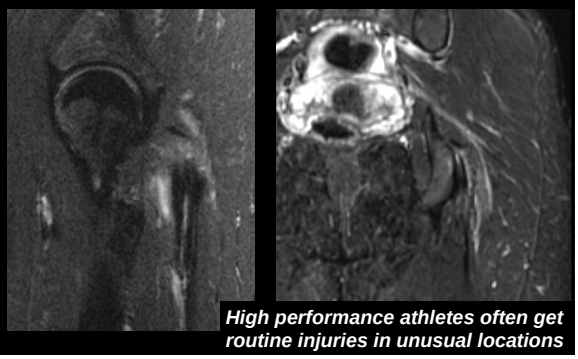
Grade 2 Muscle Strain

AKA "Partial Tear"



Marathon Runner

Quadratus Femoris Strain

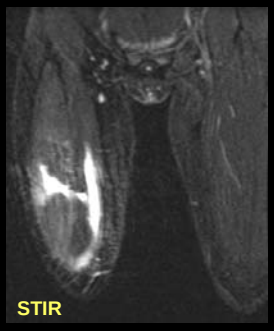


High performance athletes often get routine injuries in unusual locations

Grade 3 Muscle Strain

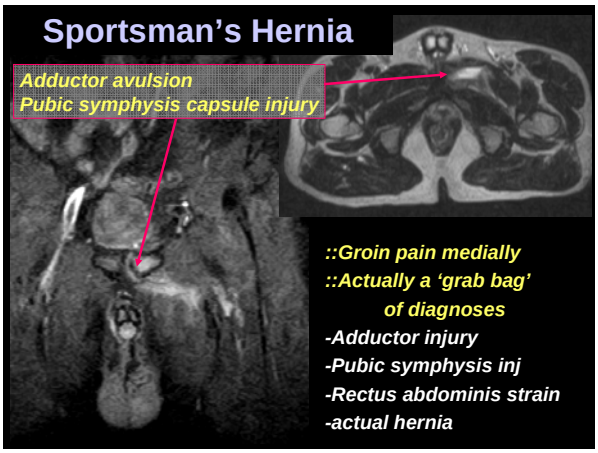
Grade 3 Strain

Rectus femoris



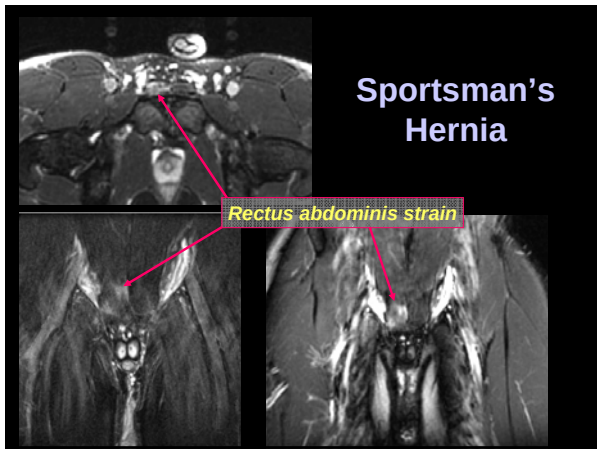
- Complete tear
  - Fluid, blood common
  - Retraction – balled up muscle may be perceived as a mass
  - Degree of dysfunction varies
    - Hamstrings, rectus femoris, tibialis anterior – loss has little effect on ADL perfomance

Sportsman's Hernia



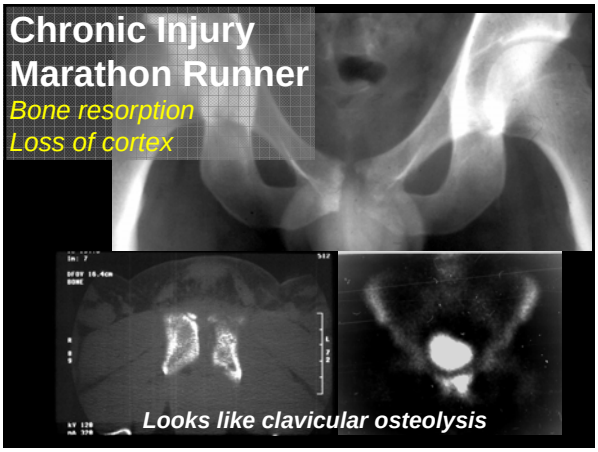
::Groin pain medially
::Actually a 'grab bag' of diagnoses
-Adductor injury
-Pubic symphysis inj
-Rectus abdominis strain
-actual hernia

Sportsman's Hernia

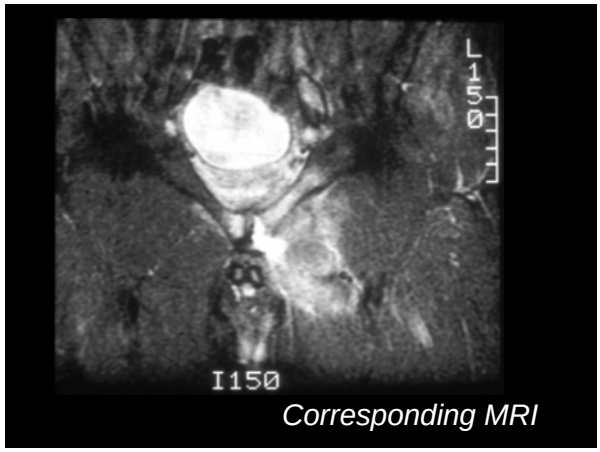


Chronic Injury Marathon Runner

Bone resorption
Loss of cortex

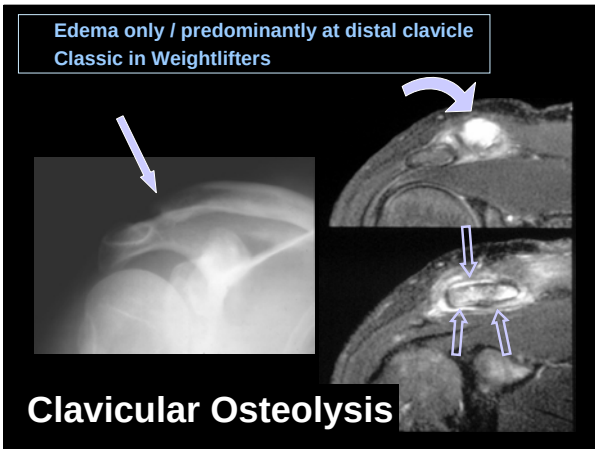


Looks like clavicular osteolysis



Corresponding MRI

Edema only / predominantly at distal clavicle
Classic in Weightlifters



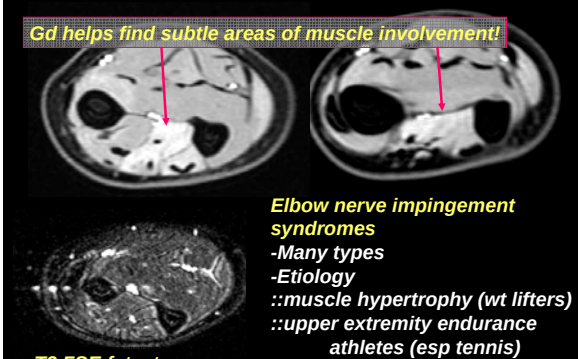
Clavicular Osteolysis

Other Muscle Pathology

Dysfunction related to nerve impingement

Compartment syndrome

Radial Tunnel Syndrome



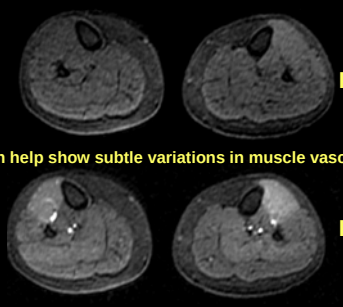
Elbow nerve impingement syndromes
-Many types
-Etiology
::muscle hypertrophy (wt lifters)
::upper extremity endurance athletes (esp tennis)

T2 FSE fatsat

Compartment Syndrome

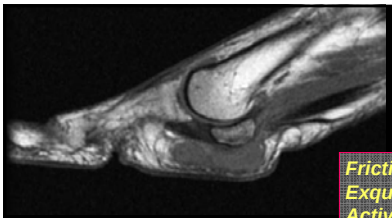
- Confined fascial compartment
  - Lower leg > thigh
  - Most common: anterior compartment
- Acute and chronic forms
  - Acute: tibial fx, hematoma, vascular injury, infection
  - Chronic: Muscle hypertrophy / overexertion
- Increased compartmental pressure (>30mm Hg)
- Decreased bloodflow into compartment
  - Clinical: pain/swelling, weakness, decreased sensation
- Late: Muscle infarction

Chronic Exercise-induced Compartment Syndrome



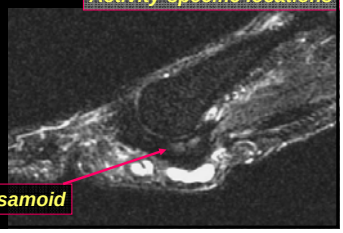
Bursitis

Adventitial Bursitis



Friction related
Exquisitely painful
Activity-specific locations

Professional Ballet dancer



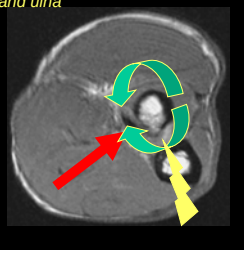
Also note stress fx of sesamoid

TENDONS

TENDON PATHOPHYSIOLOGY

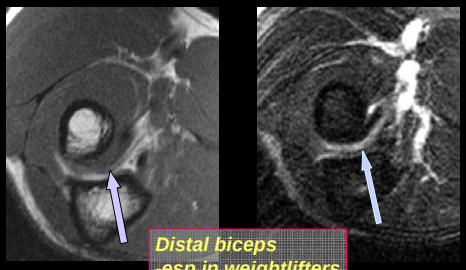
- **Degeneration**
  - -primary (overuse injury)
  - -direct frictional effect
- **Hypovascular-critical zone**
  - – Tendons without sheaths are susceptible
    - Achilles, biceps, cuff, etc.
  - – Between myotendinous jct and insertion
- **'Normal tendons don't tear'**

Example of friction: Distal biceps
Mechanical-pronation leads to impingement between radius and ulna



TENDINOSIS

- Thickening, increased signal (T1, PD, T2)



Distal biceps
-esp in weightlifters

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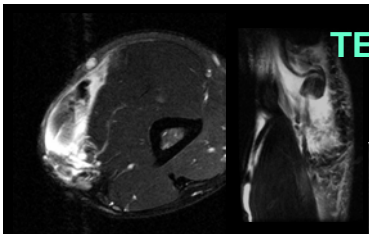
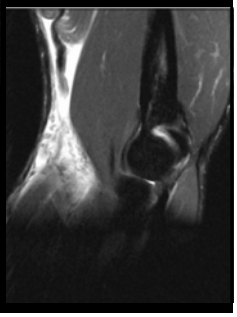
TENDON TEAR



COMPLETE TEAR: USUALLY ASSOCIATED WITH RETRACTION

– e.g., biceps: retracts, bulging muscle ('popeye' arm)



LATERAL EPICONDYLITIS

Adjacent marrow edema
-Chronic, severe, refractory cases

Epicondylitis

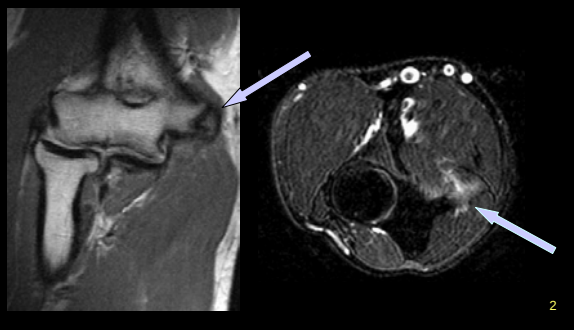
::Especially in racquet / club sports

::Lateral= tennis elbow

Muscle edema
(esp ECR brevis)

MEDIAL EPICONDYLITIS

- "Golfer's elbow"



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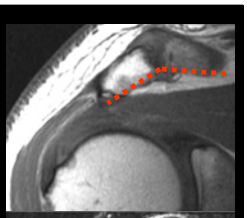
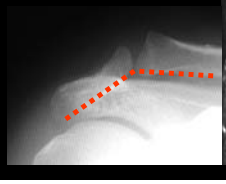
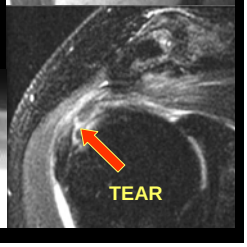
IMPINGEMENT
Rotator Cuff Tendinosis and Tear

- **Lateral acromial downslope:**
  - **–Predisposes to impingement**
  - **–Esp. common in overhead throwing sports**



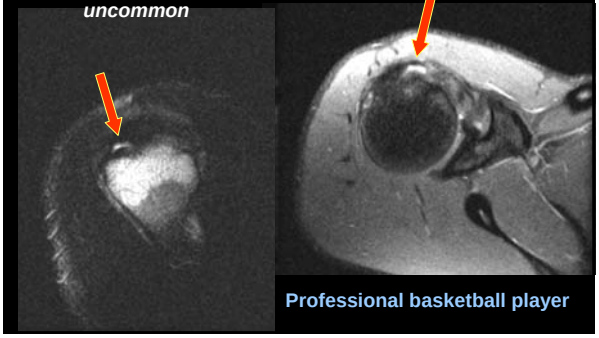




TEAR

Undersurface Partial Thickness Tear

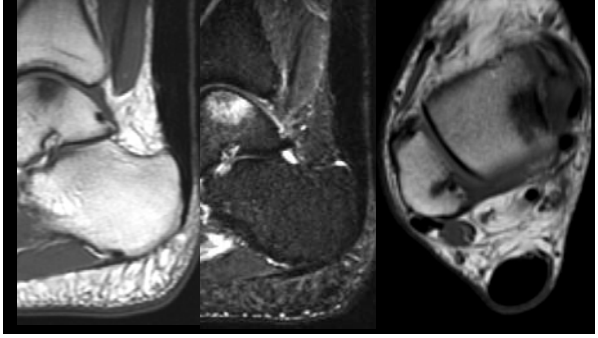
--Impingement is nearly always involved
--Underlying degeneration
--"Acute tear" extremely uncommon



Professional basketball player

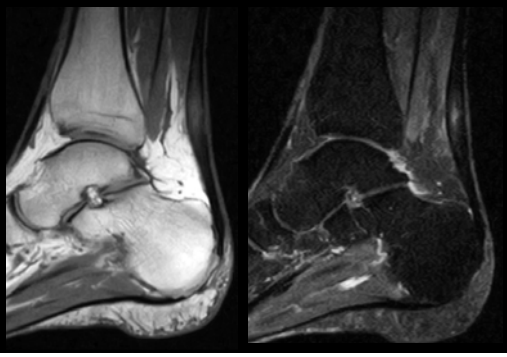
Tendinosis
Hypoxic Degeneration

Lesions at the "watershed zone"



Tendinosis
Mucoid Degeneration

Lesions at the "watershed zone"



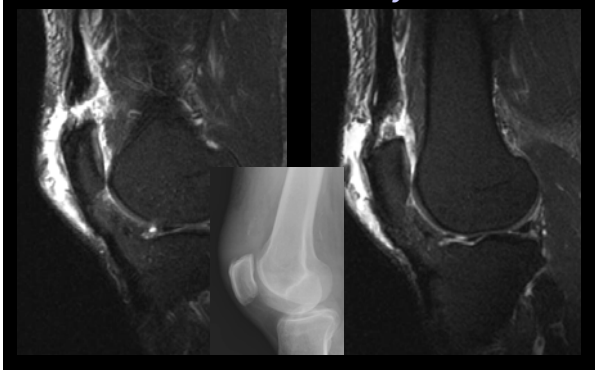
Tendinosis
Painful Enthesopathy

Edematous spur =high likelihood of sx

Professional basketball player

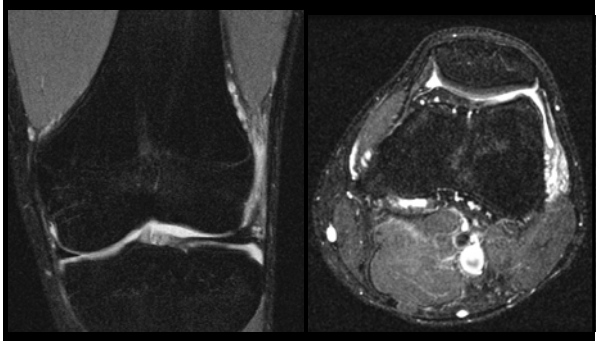
Patellar Tendinosis / Tear

Tendinosis / Tear
Pro Basketball Player



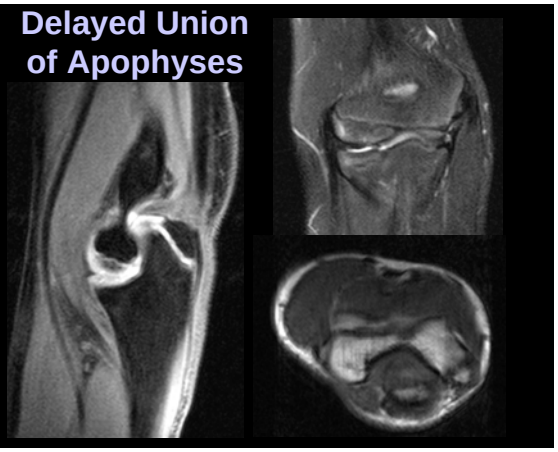
Iliotibial Band Friction Syndrome

Long Distance Runner



OVERUSE INJURIES IN ADOLESCENT ATHLETES

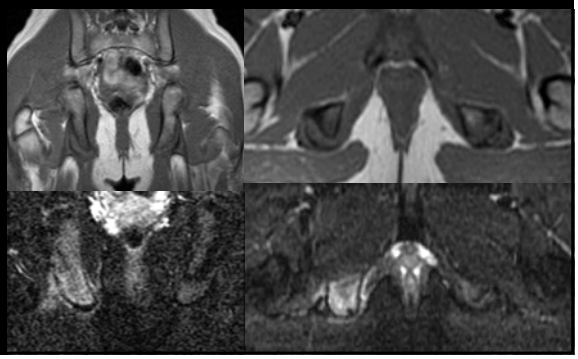
Delayed Union of Apophyses



Medial Apophysis Stress

Avulsive Stress Ischeal Apophysis

Gymnast



Old Osgood-Schlatter

Extensor mechanism pathology
AKA "Jumper's knee"
Esp. common in basketball

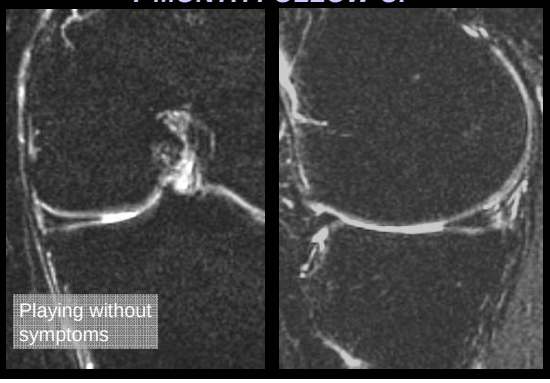
JOINTS

Cartilage Lesions

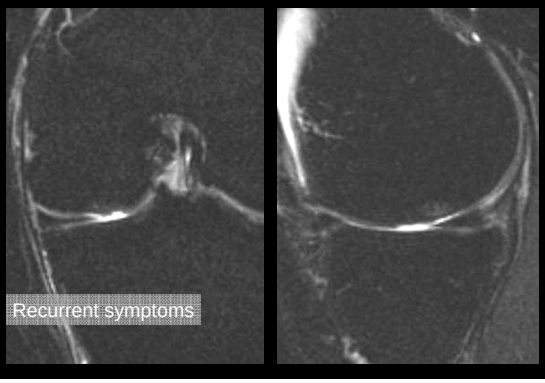
Microfracture – NBA Player

S/P MICROFRACTURE

7 MONTH FOLLOW-UP

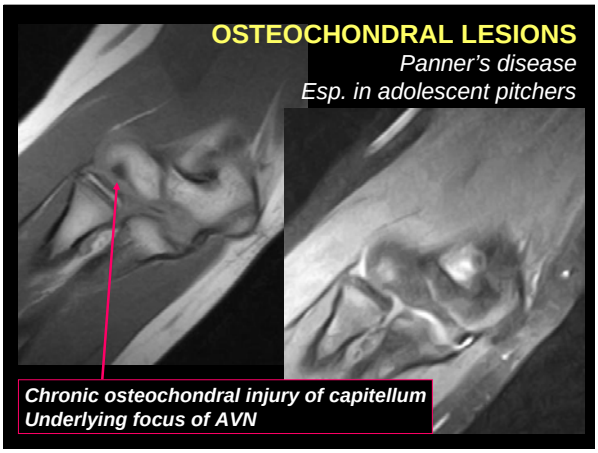


13 MONTHS LATER



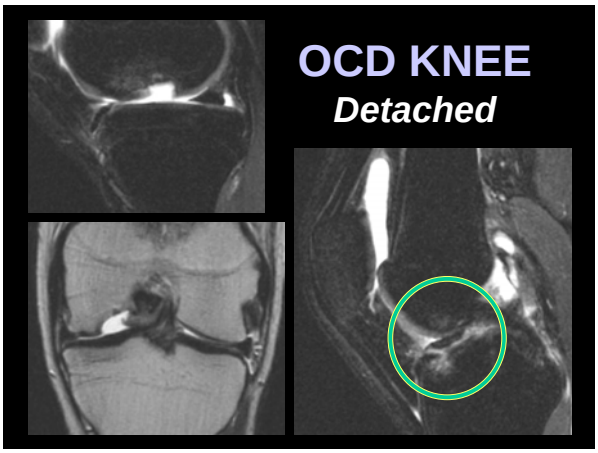
OSTEOCHONDRAL LESIONS

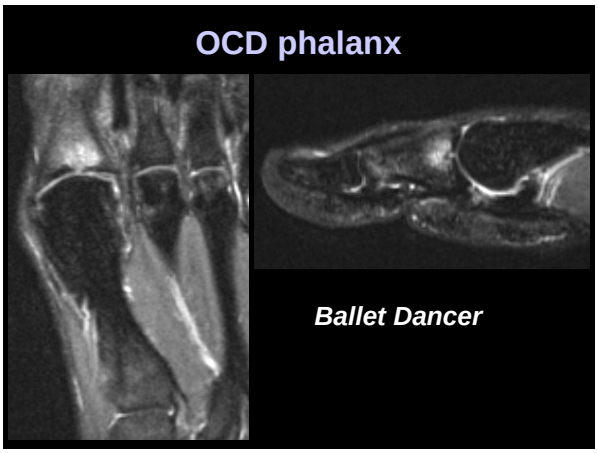
Panner's disease
Esp. in adolescent pitchers



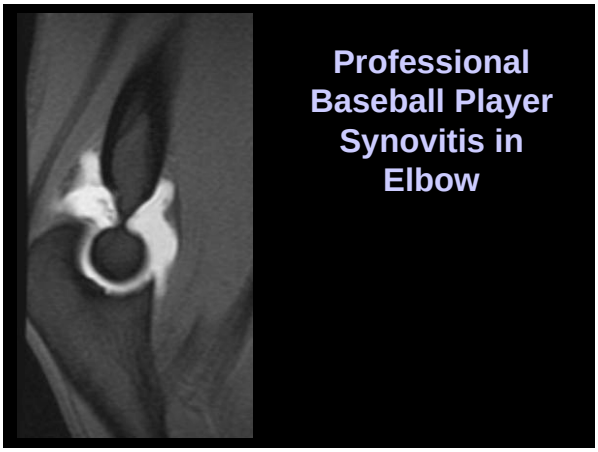
OSTEOCHONDRAL LESION OF THE TALUS

Esp. in basketball





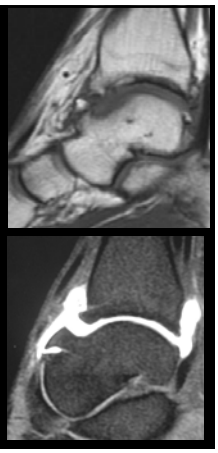
Plicas and Bodies



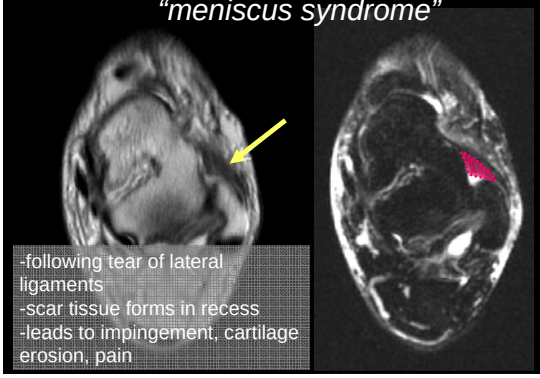
Joint Impingement and Instability

ANKLE JOINT
Impingement

Anterior impingement:
large spurs limit dorsiflexion
-esp in soccer, kicking sports



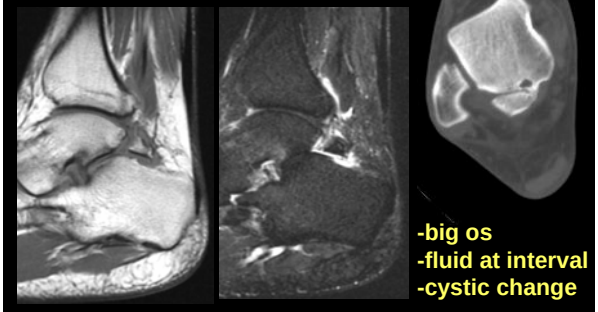
Anterolateral Impingement
"meniscus syndrome"



-following tear of lateral ligaments
-scar tissue forms in recess
-leads to impingement, cartilage erosion, pain

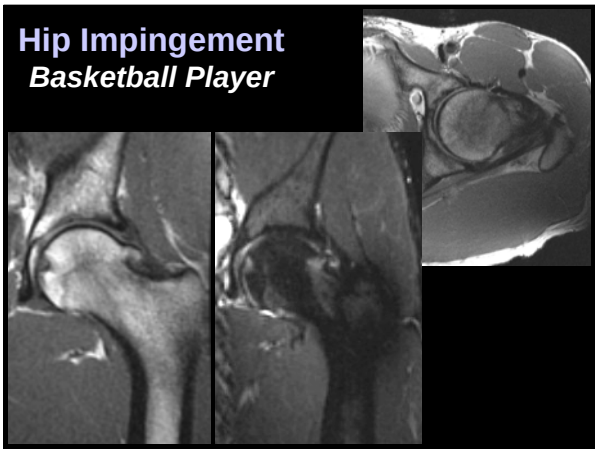
Posterior Impingement
"Os Trigonum Syndrome"

Esp. in ballet

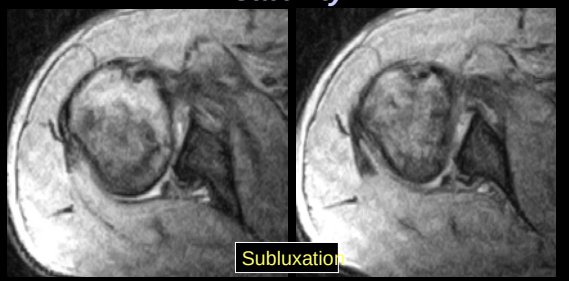


-big os
-fluid at interval
-cystic change

Hip Impingement
Basketball Player

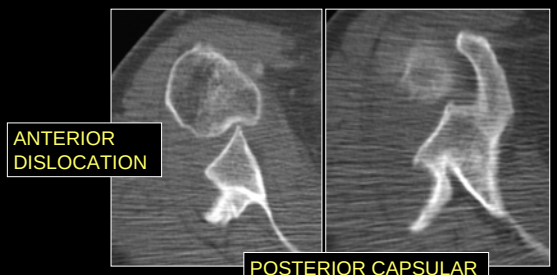


Posterior Labral Tear
Chronic Unidirectional Posterior Instability



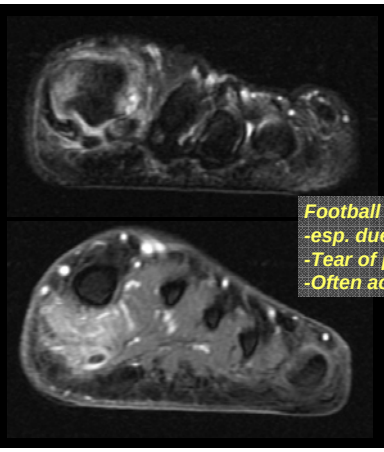
Chronic Multidirectional Instability

Combined Anterior and Posterior Instability



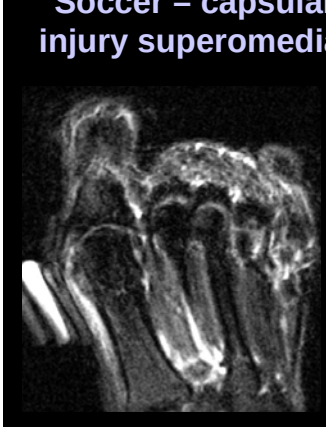
Capsular Injury

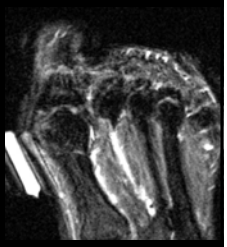
"Turf Toe"

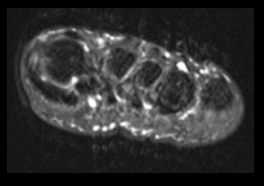


Football players
-esp. due to artificial turf
-Tear of plantar plate 1st MTP
-Often acute on chronic

Soccer – capsular injury superomedial

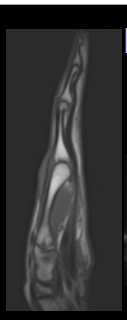


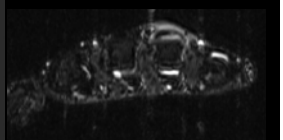


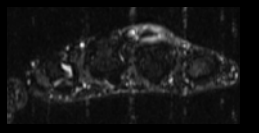


DORSAL HOOD INJURY

Boxer

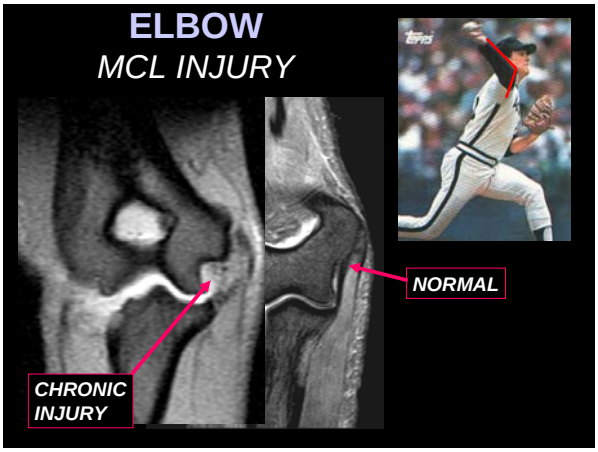


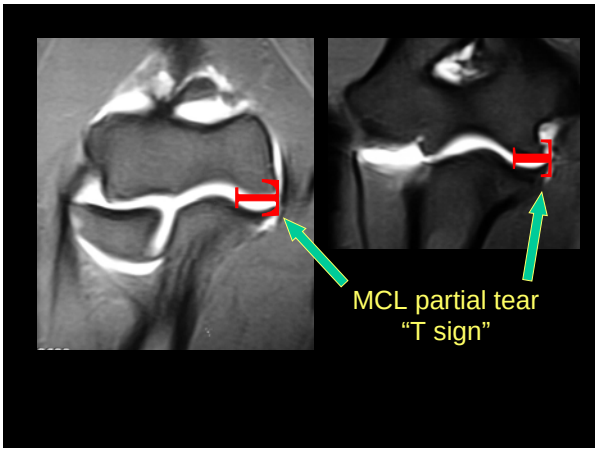


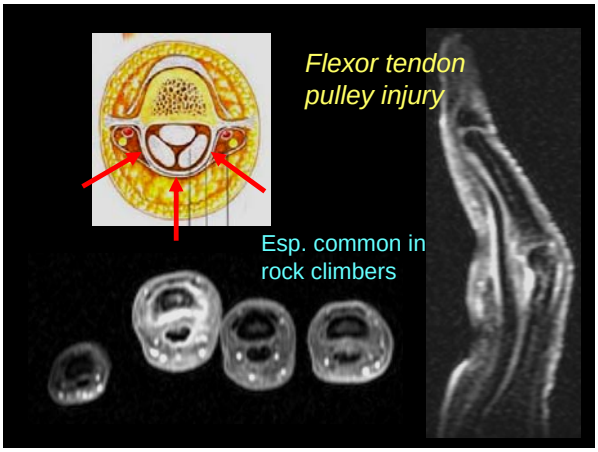


LIGAMENTS
FASCIA

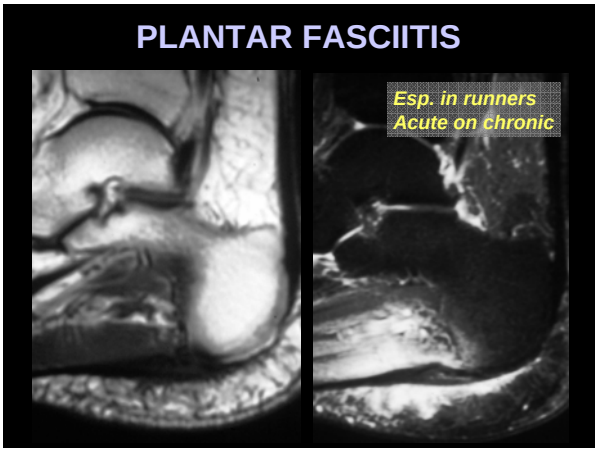
ELBOW
MCL INJURY



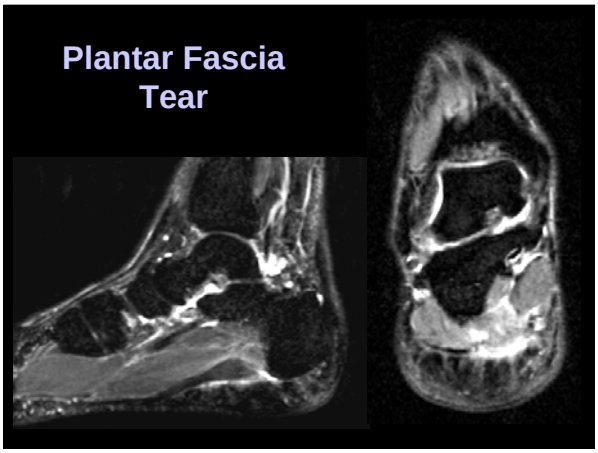




PLANTAR FASCIITIS

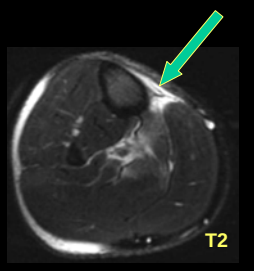


Plantar Fascia Tear



Medial Tibial Stress Syndrome

- AKA "shin splints"
- Avulsive injury medial tibial myofascial attachment
- Running, overuse
- Fascial or periosteal edema along anteromedial tibia
- Occasional marrow edema
- Most common: normal MRI



Anderson MW. Radiology 1997; 207:826

BONE

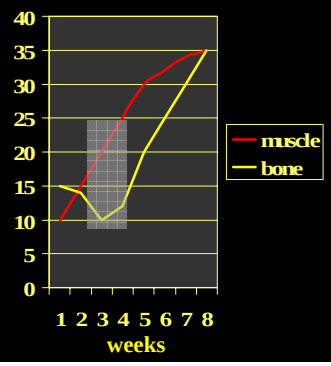
Stress Fracture

- Fatigue: 'people in fatigues'
  - Normal bone undergoing abnormal stress
  - Young people
- Insufficiency
  - Abnormal bone (eg, osteoporotic), normal stresses
  - Older population

Etiology of Stress Fracture

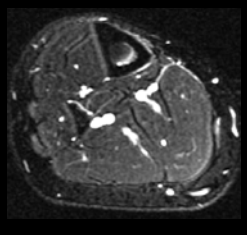
- During early phase of a new activity, muscle steadily increases strength
- Bone must undergo a phase of osteoclastic resorption first

"At risk period"



Stress Response

no linear component

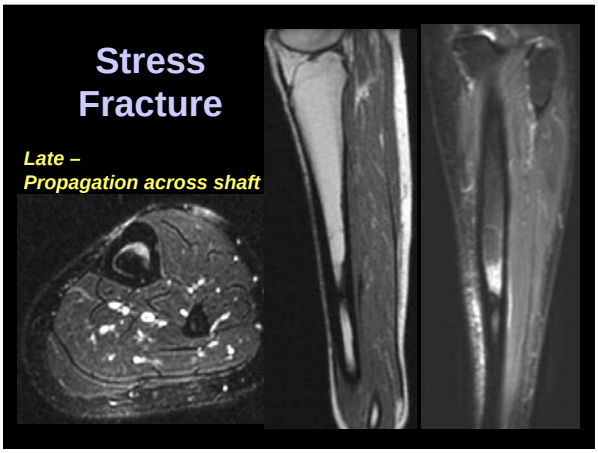


Stress Fracture

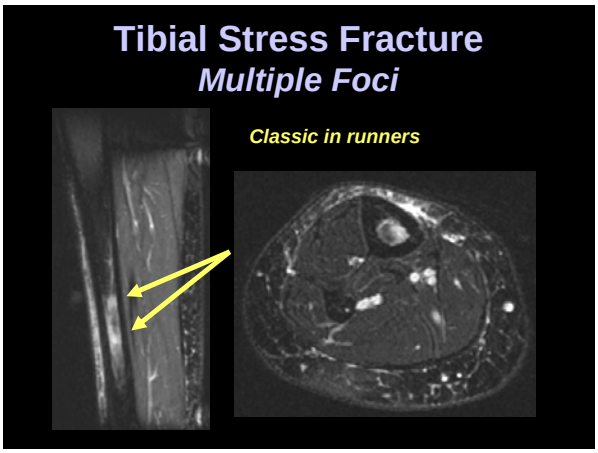
Atypical locations: periostitis may be mistaken for tumor

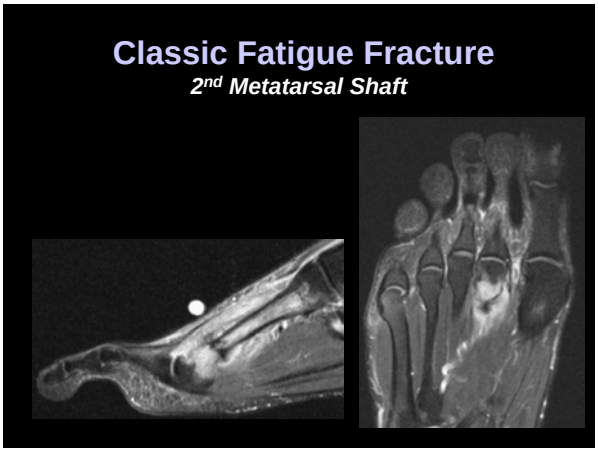
Stress Fracture

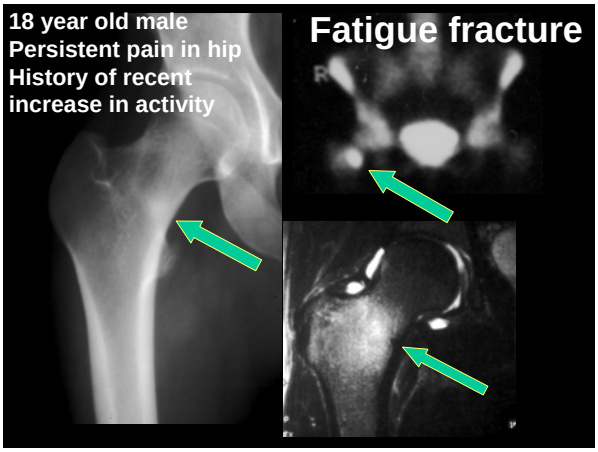
Late –
Propagation across shaft



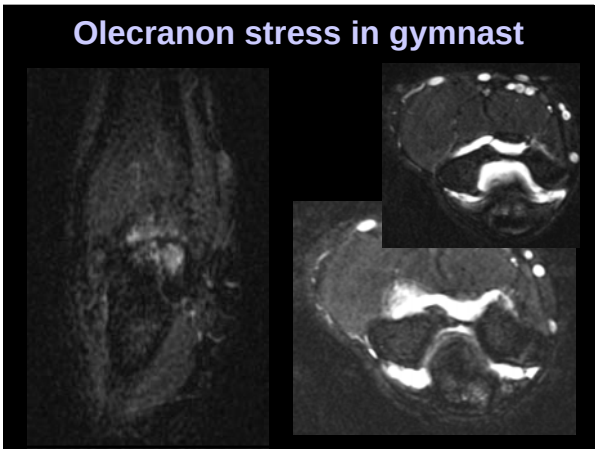

Stress Fracture
Late – Thick periostitis


Tibial Stress Fracture
Multiple Foci
Classic in runners

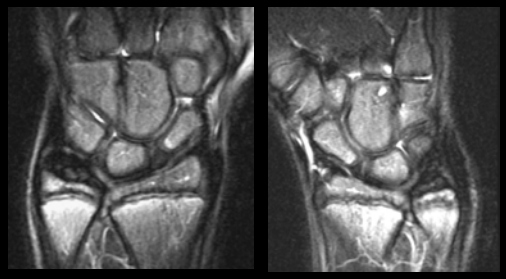

Classic Fatigue Fracture
2nd Metatarsal Shaft


18 year old male
Persistent pain in hip
History of recent increase in activity
Fatigue fracture

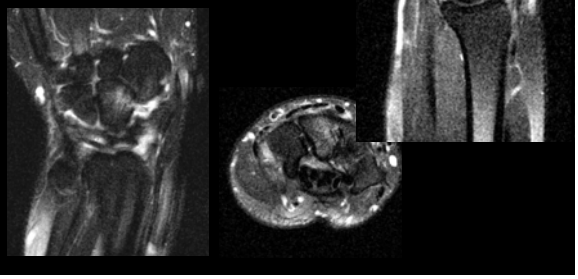

Atypical Sports-specific Locations


Olecranon stress in gymnast

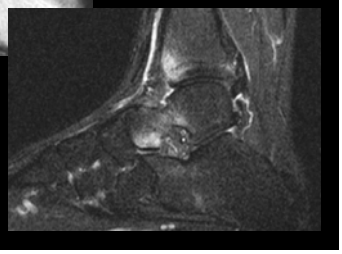
GYMNAST WITH DISTAL RADIAL / ULNAR PHYSEAL STRESS
Bilaterally



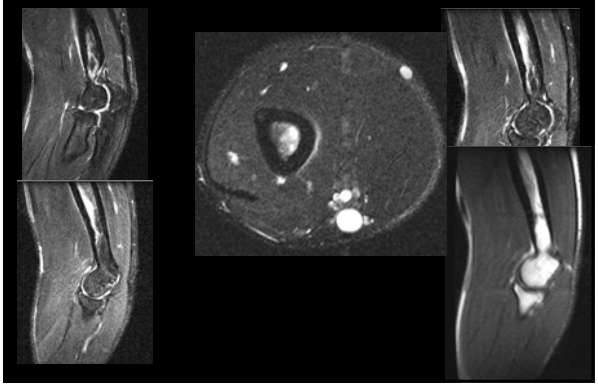
Capitate stress
Gymnast



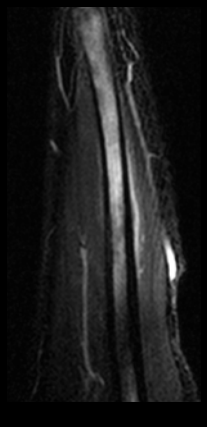
STRESS RESPONSE
Ballerina

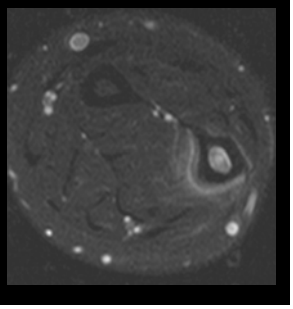


Humeral stress pitcher

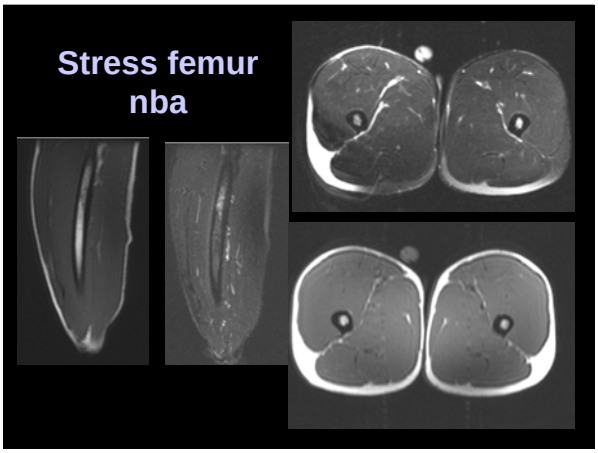


Stress forearm in female softball player

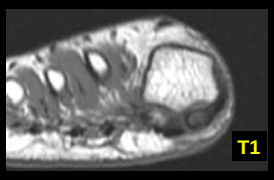


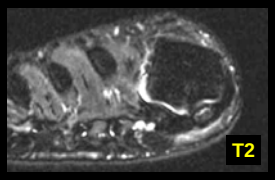


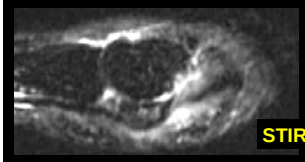
Stress femur nba



Sesamoiditis



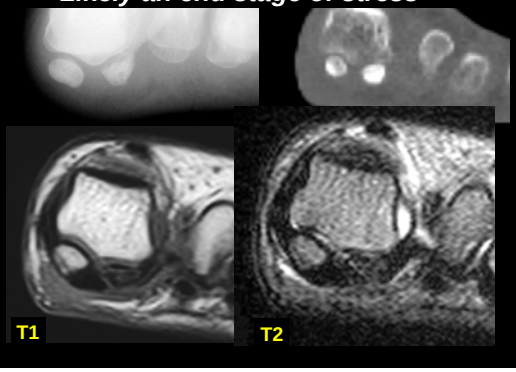




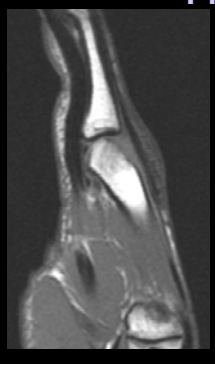
-Hyperemia likely due to chronic repetitive injury
-Prob along spectrum of stress, AVN
-Sesamoid high on T2, surrounding ST edema
-Mostly preserved T1 signal

AVN Sesamoid

Likely an end stage of stress



AVN metacarpal head (post op) Pro boxer



Dynamic Gd demonstrates viability of remaining bone